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BruscarBoom: Creating a robot Designed for Litter Cleaning.

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Project Report Book

Contents

Abstract (250 words)

Littering has become a big problem all around the country. Litter can often be seen around schools and workplaces. Additionally, it is also unbelievably bad for the planet because it can kill animals.

We chose this problem because we feel like it could be helpful to the environment around us. Although our environment is quite clean, we would like to keep it relatively cleaner so that the caretakers and cleaners don't have to do so much to keep it this way. Quite often, we see people not picking up their own litter.

When we looked at this problem, we realised that it could be resolved by building a robot that could pick up litter. Robotics is a dynamic field poised to transform diverse sectors of human life. Robotics is used for everyday necessity's such as automated vacuum cleaners. We initially looked at what kind of litter our robot could pick up.

We started our project on **September 13th 2023,** and we drew out a couple of potential designs for the robot. We further looked at what materials we would need to build the robot.

We also looked at pictures and videos of ‘quad stone pickers’ to see how that design could be useful to make our robot. Then, we looked at possible materials we would use. We had to order some materials off Amazon. Lastly, we decided to test the robot by letting it run ‘free’ in some different locations like the corridors or rooms in our school.

Introduction

We are a group of 3 girls (Addison, Ieva & Mariska) in 2nd Year, and have an interest in building and creating projects. We're all interested in building things, like Lego. We also do engineering as a subject in school. Two of us take DML (Digital Media Literacy) classes and one of us takes coding classes at school. One of us also has a big interest in computer science, she has competed in a few competitions with computer science projects before and has won awards. These are some of the things that brought us together as a group in the first place.

Littering in Ireland is a huge problem as it affects everyone in a lot of different ways. Too much litter in populated areas can decrease the quality of air in that area. Littering also has many negative effects on people.

We chose to do this project because we noticed that the cleaners and caretakers in the school always have a lot of work to do after students have left the school to go home. We have also noticed a lot of litter around public places in Ireland that rarely ever gets picked up.

Our project involves the creation of a robot that helps pick up litter off a smooth surface or off the floor. The robot can be used to help pick up the rubbish in a school environment. We have put a lot of thought and effort into the making of the robot. The design of quad stone pickers also impacted our design choices. A quad stone picker is used to pick up rocks and stones on fields. We were inspired by the design of a quad stone picker, because we found that it had a unique design that could serve as a good overall idea as to how we wanted it to look.

A simple analogy for our robot could also refer to a quad stone picker. These machines go around in fields and scoop rocks and stones off the ground, which helps clear the area for workers. Our robot works in a similar way where it moves around a smooth surface and sweeps rubbish into a compartment where it's stored.

Our hypothesis is that a robot designed for litter pickup can make an impact in our school and communities' lives, as litter has become a huge problem in our society. Littering affects animals, as a huge number of animals die each year from litter ingestion. Littering also affects the climate in general, which is making a massive impact on oceans and on land. Our project aims to resolve this problem on a smaller scale and in our local community. This project could be developed on a larger scale in the future which would make a significant change to multiple towns and possibly cities.

Explanations of Components and Terms

In this section of our report book, you will find explanations of each primary component of the Report Book. These Primary Components are Littering in Ireland, SDG Goals, and Robotics.

Littering In Ireland

Littering can be described as improper disposal of waste products. Littering is a big problem worldwide. This has caused many animals to die from ingesting plastic or being trapped in plastic bags and plastic 6 ring holders.

Negative Impacts:

- Dumped garbage can kill or stunt plant growth.
- Litter can lead to soil, water, and air pollution.
- Harmful to humans, animals and the natural environment.
- Litter can create breeding grounds for pests, like mosquitoes, which may contribute to the spread of diseases.
- Broken glass, sharp objects, or hazardous materials in litter can pose physical risks to people, especially in public areas where individuals may walk barefoot, like the beach, or engage in recreational activities.
- Tourist destinations and communities may suffer economically due to decreased property values and a reduction in tourism.
- Litter can clog storm drains and contribute to flooding during heavy rainfall.
- Litter can contribute to soil erosion, affecting the stability of ecosystems and increasing the risk of landslides in certain areas.

- Many litter items, especially plastics, take a long time to break down in the environment, contributing to the persistence of pollution over an extended period of time.

The Government has tried to reduce littering in many ways. They have tried to reduce it by having €5 million additional funding to the Local Authorities for litter infrastructure. The Minister has also approved €225,000 in funding for ‘An Taisce’ in support of an extended 2021 National Spring Clean programme. Members of the Irish Waste Management Association in every county in Ireland have agreed to work with DECC (Department of the Environment, Climate and Communications) to develop proposals that will assist with litter clean ups in local communities. DECC continues to promote and support a number of environmental awareness raising programmes, including the Green Schools Programme, aimed at educating our young people on all aspects of the environment and the Anti-Litter and Anti-Graffiti Awareness Grants Scheme (ALAGS), (DECC, 2021).

Littering is a problem in schools all over the world, including Ireland. There are a number of factors that contribute to littering in schools. One fact is that schools are often crowded places with a lot of foot traffic. This can make it difficult to keep the hallways and classrooms clean. Another fact is the lack of adequate waste disposal facilities. Many schools don’t have enough bins, or the bins that are there might now be located in convenient places. There are a number of things that can be done to reduce littering in schools. The school could increase awareness to the problem. They could also improve waste disposal facilities and make sure they’re emptied regularly. Schools can also encourage students to take responsibility for their own litter.

Overall, littering poses severe environmental, social and economic consequences. From pollution of land and water to inflicted upon wildlife, the negative impacts are extensive. Littering not only diminishes the looks of public places but also poses risks to public health and safety. Addressing this issue requires collective efforts. By taking responsibility for our surroundings and adopting sustainable practices, we can create a cleaner and healthier environment for all.

SDG/ESG Goals

The SDGs (Sustainable Development Goals) are 17 goals that are a call to action to end poverty and inequality, protect the planet, and ensure that all people enjoy health, justice and prosperity.

In our project we will be looking at the following goals:

- Life on land (Goal 15)
- Climate action (Goal 13)

Life on land can be described as protecting and restoring of ecosystems. The loss of terrestrial ecosystems is very detrimental to our society. It has a direct impact on the local fauna and flora (animals and plants), which in turn affects the human living environment.

For example, deforesting, when trees are felled, not reseed and the area is left barren. Some other impacts are also observed as following:

- The habitat of animals (large and small, winged and not winged)
- The natural shelter the woods offer against natures storms.
- The ecological impact of ground erosion and the reduced ability of natural photosynthesis.
- The ability to filter ground water.
- Forest offers shelter, food, building materials and can offer drinking water.

Without food or habitats, animals would perish. The absence of animals means no food for humans, leading to the deterioration of life itself. That’s why re-planting trees, picking rubbish after yourself and keeping a pattern of life is important. Over one million animals die each year because of how litter affects animals and humans, this is one reason of why we decided to make a litter picking robot.

Climate action can also be described as stepped-up efforts to reduce greenhouse gas emissions and strengthen resilience and adaptive capacity to climate-induced impacts. One example of this can be to save energy. This means turning off unnecessary lights, have the heating on for less time, spend less time in hot showers. Another example is using less food waste. Food waste is a big problem. Over a quarter of the world's food is wasted from not being used before it is out of date, or from leftovers. When the food is left to rot, it releases harmful methane gases that affect the climate negatively.

It's very common in schools to talk about the SDG goals. For example, in our school we have the Take 1 Program. This program aims to raise awareness and support schools and embed education for sustainable development. Their objective is to provide professional learning opportunities to engage with and understand Education for Sustainable Development. Another one is 'Eduropia' which has multiple different programs to transforming pre-K-12 education so that all students can acquire and effectively apply the knowledge, attitudes, and skills necessary to thrive in their studies, careers, and adult lives.

In summary, SDG goals are help and save not only the environment but also human and animal lives. They serve as a global blueprint for a better future. Achieving these goals demands united efforts to address challenges and create a more sustainable and inclusive world by 2030. It is a collective responsibility to ensure a prosperous and equitable future for all. These goals inspired our project because the SDG goals gave us an outline to where there are problems in the appropriate topics we were looking at.

Robotics

Robotics is a branch of engineering and science that includes electronics engineering, mechanical engineering and computer science and so on. This branch deals with the design, construction, use to control robots, sensory feedback and information processing (Agarwal, 2023). Robotics Engineering can be described as a combination of various engineering disciplines, like:

- Computer Science
- Electrical and Electronic Engineering
- Mechanical Engineering
- Design Engineering

One of the objectives of the robotics field is to create programmable machines, which can perform repetitive tasks with exact outcome. This is of great benefit to humans specially in the manufacturing industry, like vehicle manufacturing and semi-conductor manufacturing but to name only two.

Robotics is used for everyday necessity's such as automated vacuum cleaners, robotic lawn mowers, and personal robots designed for home use. Robots have been considered as replacement for humans in repetitive jobs in public spaces (Maeda R, 2021). It also links in well with engineering and multiple strands of computer science such as Artificial Intelligence.

Artificial Intelligence AI refers to the development of computer systems or machines that perform tasks that would typically require human intelligence. It creates intelligent systems that can perceive, learn, reason, and make decisions similar to how humans do. It involves developing algorithms and computer programs that learn from and make predictions or decisions based on data. These algorithms can be trained on large datasets, enabling them to recognise patterns and make predictions or decisions that are accurate and consistent.

AI can serve as the ‘brain’ of the robot, while the sensors and mechanical parts act as the ‘body’. AI, ML, and DL are transforming the field of advanced robotics, making robots more intelligent, efficient, and adaptable to complex tasks and environments. (Soori, 2023).

Positives Impacts:

- It is consistently accurate.
- Does not get tired.
- Has no problem with laborious work.
- Does not require a salary.

- Low rate of reworks due to equipment malfunction.

Negative Impacts:

- Replaced unskilled and general operative workers.
- Reduces the work force.
- Expensive
- Needs skilled labour to maintain and repair.
- High failure rate due to human error.

In conclusion, robotics is a dynamic field poised to transform diverse sectors of human life. With ongoing advancements in artificial intelligence and technology, robots are becoming increasingly sophisticated, offering the potential for enhanced efficiency and safety across various industries. Despite ethical considerations, the evolving landscape of it promises innovative solutions that can positively shape the future.

Our Code / Experimental Methods

In this section, you will find a breakdown of the code involved in the creation of our robot, our design choices, and the steps we took to make the physical model.

We decided to create our project using the principles of User-centred design (UCD). This is a design approach that focuses on creating products, services, and experiences that are centred around the needs and desires of the people who will use them. To achieve this, UCD relies on a set of principles that guide the design process. These principles include:

- Empathy: Understanding the needs, goals, and motivations of the users and putting oneself in their shoes.
- Collaboration: Involving users in the design process and collaborating with them to co-create solutions.
- Iteration: Prototyping and testing ideas quickly and repeatedly to refine and improve the design.
- Inclusivity: Designing for the diverse needs and abilities of all potential users.
- Accessibility: Creating products and services that are accessible and usable by people with disabilities.
- User testing: Gathering feedback from users and using it to inform and improve the design.

We decided to apply UCD using the Agile Framework. Agile methodology is a project management approach that enables flexibility and empowers practitioners to engage in rapid iteration. It is based on the Agile Manifesto (Fowler, 2001), a set of values and principles for software development that prioritize the needs of the customer, the ability to respond to change, and the importance of delivering working software regularly. Agile methodologies, such as Scrum and Lean, are designed to help teams deliver high-quality products in a fast-paced and dynamic environment by breaking down complex projects into smaller, more manageable chunks and continually reassessing and adjusting the project plan as needed. Agile teams are typically self-organizing and cross-functional and rely on regular communication and collaboration to achieve their goals.

We managed our Agile system using Kanban (Fig.1).

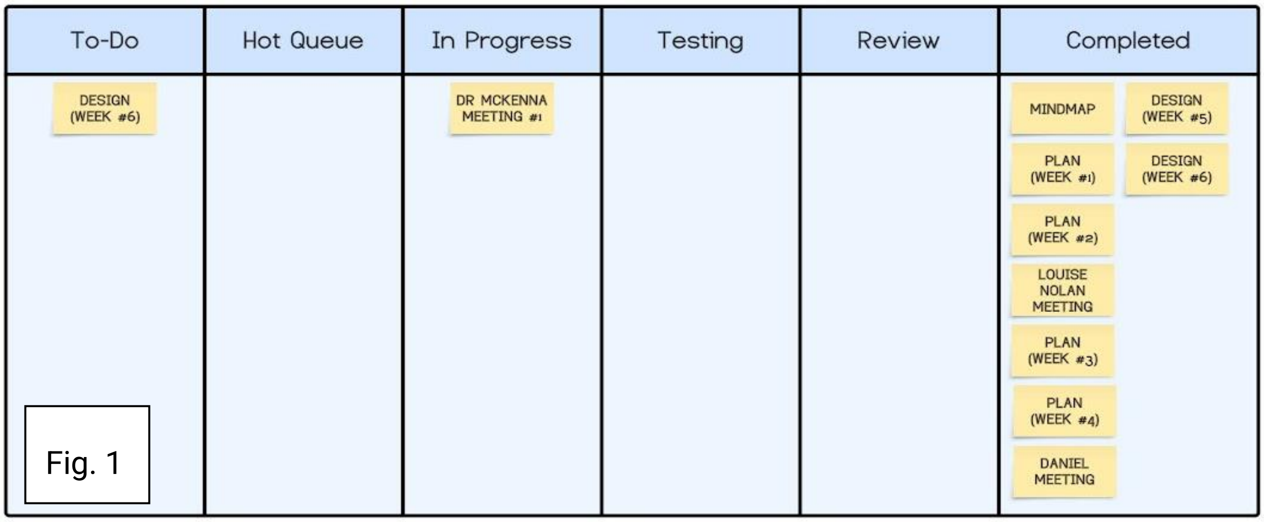

Fig. 1

Kanban is a project management method that originated in Japan in the 1950s and is based on the principles of lean manufacturing. It is designed to help teams visualise and optimize their workflows by breaking down tasks into smaller, more manageable chunks and tracking their progress through a series of stages. Kanban uses a visual board to represent the distinct stages of a project, with cards representing individual tasks and columns representing the various stages of the workflow. The goal of Kanban is to increase efficiency and transparency by making it easier for team members to see where work is in the process, identify bottlenecks and inefficiencies, and adjust as needed. Kanban is often used in conjunction with other agile methodologies, such as Scrum, to help teams manage their work more effectively. (Corona, 2013).

Please scan here for our full Kanban journey (Project Diary).

Section 1:

Planning Phase

We started our project by creating a mind map (Fig. 2) of all the potential ideas that we could pursue through the lens of Robotics. We discussed different problems in areas like our community, school, and at home. After reviewing our ideas, we discussed what ideas would be possible to create a robot for. We also decided to look towards a topical issue.

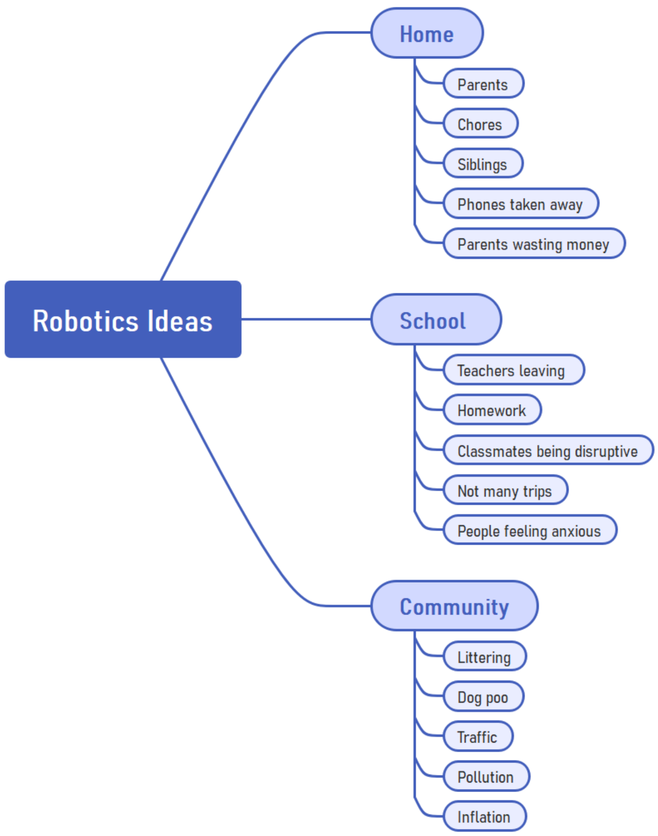

Fig. 2

We decided to zone into two ideas (Fig. 3). Both ideas had some potential, but we were unsure on which to pick, as both came with challenges. We figured we would need to properly discuss both ideas to someone else with more of an engineering background to see which idea would be more achievable in the time frame we have and settle our final idea.

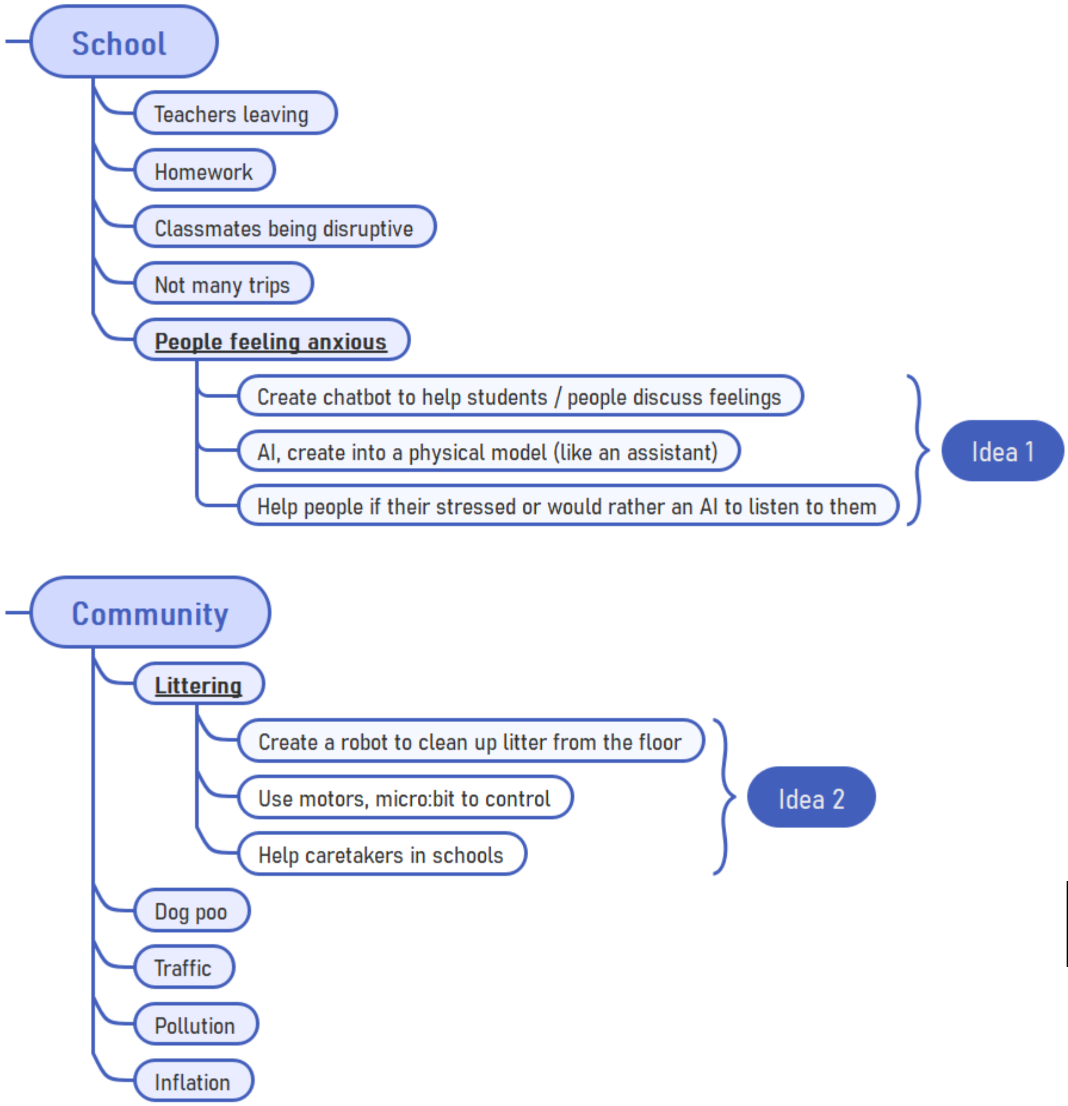

Fig. 3

After cutting the list down to those two ideas, we decided that it would be best to talk with someone who could help give us some advice towards our final decision. We met with a woman called Louise Nolan on a call. Louise is a maker and creative technology designer. She was paired up with us by TeenTurn to discuss our ideas we have for our robot project.

Over the call we had, we discussed various things required in both of our projects. Our first idea using a chatbot, is more of an AI and Machine Learning project which would involve a huge amount of code. This idea would also involve a large amount of testing considering we would be developing an AI model. Our second idea involving creating a physical robot, would be more of a robotics project and involve more practical work than coding.

Below are some of the various points that were discussed and suggestions we were given during our meeting:

Idea 1: Using a chatbot to help students communicate thoughts and feelings:

- Using this chatbot could help solve issues outside of school.
- How would the AI react to certain questions? – training data?
- Chatbot would cost less to develop.
- Visuals – chatbot would involve wire-framing.
- Possibly find some source code to help & share through GitHub.
- Possibly survey people or year group about the idea – would they use it & why?
- Developing the chatbot could take a long time – limiting our time for other aspects of the project.
- Discuss with other teachers in our school if we need further advice.

Idea 2: Using a robot to pick up litter from the floor:

- Using this robot would help resolve a school issue with littering (at lunch)
- Think about aspects like tripping hazards, benefits of keeping the school clean.
- We would have to buy certain parts to build the robot (possibly more expensive)
- Use motors and a Micro:Bit for the robot to move.
- Creating this robot would take significantly less time – more time to focus on other aspects of the project and how it physically looks.

- Possibly survey people or year group about the idea – would this be a good idea for our school?
- How would this look in the end result? – plan our design?

The following was a design idea **suggested** by Louise that we could've possibly used for the design for the litter robot:

- Use a robot with vision capabilities.
- Buy a robotic vacuum – attach robotic arm to pick litter.
- 'Hack' vacuum robot to detect litter and pick it up using the arm.
- Look on websites like Amazon, AliExpress, Temu, Shein for vacuums.
- Look at motors for moving joints, spinning, back & forth.
- Robot kits – include motors, control board, cables, materials, screws & bolts.
- Possibly cost less than €100.
- Search up line following robot / car – vision sensor, follows dark lines, change visual sensor.
- User journey mapping.

She also reminded us that we can discuss and talk again if we need further help, as Louise is a very creative person when it comes to designing technology. She recommended us to talk with the engineering and coding teachers in our school to get their opinions on our ideas. She further recommended us to survey our year group if we wanted to get more opinions on our ideas.

After this meeting, we discussed as a group on what each of us thought personally. We ended up settling on **Idea 2**, creating a robot to pick up litter from the floor. We chose this idea based on multiple factors. Firstly, we are aware that littering is a huge problem, not only in our community but in our school. We thought that this robot could play an important role in helping people like our caretakers, as they work very hard to keep the school clean. We also kept mindful of the timeframe we had to complete this project. TeenTurn designed the duration of our project to take place over 12 weeks including planning, design, development and testing phases. We figured this project would take a significantly lower time between the practical work and coding. We also discussed our different roles and talents we have and how this would impact our project. Some of us are more creative, while some of us are more technical than one another. Chatbots and AI involve a lot of coding. If we chose that project, it would've been quite unfair. Not every member in our group have done coding before, or further developed an AI model. Choosing the robot for littering meant there would be a larger practical part in which we could all play a huge role in participating in. There would also be less of a coding element, which that could be left up to whoever wants to take that role.

After making our final decision to continue with the litter picking robot, we discussed our idea with our engineering teacher. We told him about the potential design choice that Louise suggested and his opinions on it. We figured that using a robot vacuum and a robot arm would be time consuming. It would also cost a lot of money as we would have to order a robot vacuum, robotic arm, and the various other parts to connect the two. With our level of experience, we also figured that 'hacking' the vacuum to fit our requirements isn't something any of us are entirely familiar with. We also realised that using Louise's idea would really limit our creativity and we would have to think externally about how we would store the rubbish when it was picked up by the robotic arm.

We had to start thinking of planning our design ideas and how we could use designs of other machines to create our robot. One of us suggested about how she saw a quad stone picker being used in a field down in the countryside. We looked at various images of quad stone pickers and thought that this idea could work for our project. We discussed this idea with our engineering teacher, and he agreed that this could potentially work if we made certain modifications.

Section 2:

Design Phase

During the designing phase of our project, we had to plan out the physical design of how we wanted our robot to look, and also plan how we wanted our Micro:Bit to work with the motors in our robot. This phase was a very important step as we had to figure out what design we wanted to create, find correct dimensions. We also had to find out what equipment, materials, and parts would need to be used in our robot.

Like said previously, we decided to use a modified design of a quad stone picker to collect the rubbish. We looked at multiple images of these machines and watched a few videos to see how they work in action. Quad stone pickers (Fig. 4, Fig. 5) are made for picking up field stones in agriculture, suitable for ATV/UTV vehicles. With the machine, people save lots of time and give employees a much better work environment while collecting stones on the fields. (ApS, 2023)

Fig. 4

Fig. 5

Above are two example images of quad stone pickers (Fig. x, Fig. x). The long piece connects to the back of an ATV or UTV vehicle and the stone picker scoops up stones as its moved along. Since we will be powering the robot by itself, we didn’t need to add this feature. We thought about how we could use the same style but fit the design to our needs and requirements. We would also need to think about how our robot would move by itself following commands given in code, without the need for it to be pulled along with another vehicle.

As seen in the examples above, the stone pickers use a ‘paddle’ that lifts and spins to pick up stones. We came up with the idea of using some sort of brush to spin in a circular motion to sweep up dirt or rubbish into the main area where it will be stored. Since we aren’t using a paddle like in the stone pickers, we decided to put two wheels at the back, so the robot is on a slant. This creates a slight ramp for the rubbish to sweep up into.

Here is a diagram of the main part if our robot originally before we added the other components (Fig. 6). There is an opening at the front, where we will make an attachment for the brush on either side. The large area in the centre is where the rubbish will be stored when it is swept up. The two holes on the rear end of each side is where we will put the wheels when we drill them.

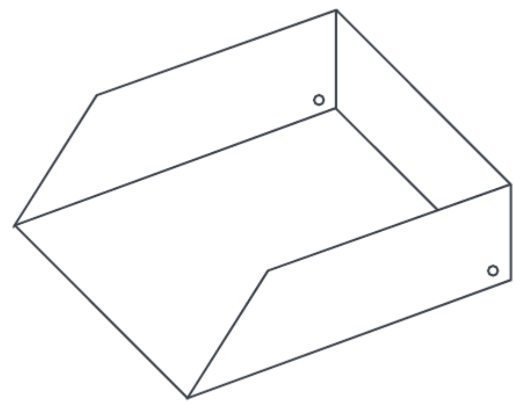

Fig. 6

There are multiple features and parts we had to design and think about including in the robot. Below are some of the extra parts we needed to attach to the robot:

- Brackets to keep the corners of the robot at a right angle, so no litter falls through a crack between two sides.
- An attachment at the front to hold the chosen brush. This would be attached to the base of the robot and there would be a hole to slot the different brushes into, if we wanted to switch them out
- An attachment for two switches at the front. Every time the robot hits a wall, one of the switches will click and the robot will reverse and turn away from

the wall. This makes sure the robot doesn't continue running into the wall and would need manual help to turn it.

- We also thought about the other parts we would need to add, like motors, wheels, battery holder, a Micro:Bit, kitronik robotics board, and switches.

We had to think about the designs for these various parts. They needed to be designed to fit onto the robot easily. It was important we measured the parts correctly and lined them up to the robot correctly or we would have to make further modifications to fix the mistakes.

We had to choose what types of brushes we wanted to use for the robot. We had ideas of using toilet brushes or sweeping brushes. If we used either of those types, we would have to use a separate rod to spin the brushes around. We came up with the idea of using round, duster-type brushes so the rod would already be 'built in' to the brush. We chose a set of the following brushes (Fig. 7) from Amazon. The set came with a few different types of dusters so we could pick and choose which ones we wanted to try. It was helpful to have a selection of different styles of brushes as well because some of them obviously have different shapes and purposes, which could impact the way our robot collects rubbish. For example, one of the brushes might be more helpful for collecting up smaller pieces, while a different brush might be able to collect larger pieces of rubbish into the main area.

Fig. 7

For presentation purposes, we wanted to make our robot look somewhat nicer rather than leaving it as the normal aluminium colour. We decided to use vinyl to wrap the aluninium base so the final product will look nicer. We got the idea of using pink vinyl to wrap the robot because we wanted to honour our engineering teacher as his favourite colour is hot pink. We also wanted to include some representation of our school somewhere on the robot. We decided that we could cut out the letters ‘CCS’ in a coloured acrylic and attach them to the side of the robot.

The images below are some of the items we ordered and the parts we decided to use in the robot (Fig. 8). The items include two of the dusters, wheels, switches and vinyl.

Fig. 8

Some of these items made an impact on the dimensions and design of the robot. For example, we had to make sure the brushes were long enough or if they were too long then we would have to cut them down. Or if the wheels needed to be bigger or smaller to support the weight of the base. Most of these items were already in our school, but the brushes and vinyl needed to be ordered online as we didn’t have anything in our school similar.

Additionally with all the physical planning, we had to think about planning our code and how the Micro:Bit would work here. In order for the Micro:Bit to move the motors, we had to get a Kitronik All-in-One Robotics board.

The Kitronik All-in-One Robotics Board for Micro:Bit is an expansion board designed to enhance the capabilities of the BBC Micro:Bit for robotics projects. It provides a convenient platform for building and controlling robots, offering various features such as:

- Motor Drivers: The board includes motor driver circuits, allowing you to control DC motors for movement in your robotics projects.
- Servo Connections: It provides connections for servo motors, enabling precise control over motorised components.
- Sensor Inputs: It has inputs for connecting various sensors, expanding the range of environmental data the robot could collect and respond to.
- Edge Connector: the board connects to the Micro:Bit through the edge connector, making it easy to attach and detach the Micro:Bit for programming and experimentation.
- Expansion pins: there are extra pins for further customisation and connection of additional components.

When using the board (Fig. 9), you can program the Micro:Bit to control your robot using languages like MicroPython or the Microsoft MakeCode block editor. MicroPython is an open-source and efficient implementation of Python 3 that is optimised to run on microcontrollers and small embedded systems. The Kitronik Robotics board is a versatile tool for educators and students interested about robotics and programming with the Micro:Bit platform. Our robotics board has 8 servo channels, 4 DC/ 2 stepper motor channels and 17 I/O expansion points. To save time with the coding side of it, we decided to use the Microsoft MakeCode block editor instead of using Python. This way every member of the group would be able to easily understand the code written in block form instead of

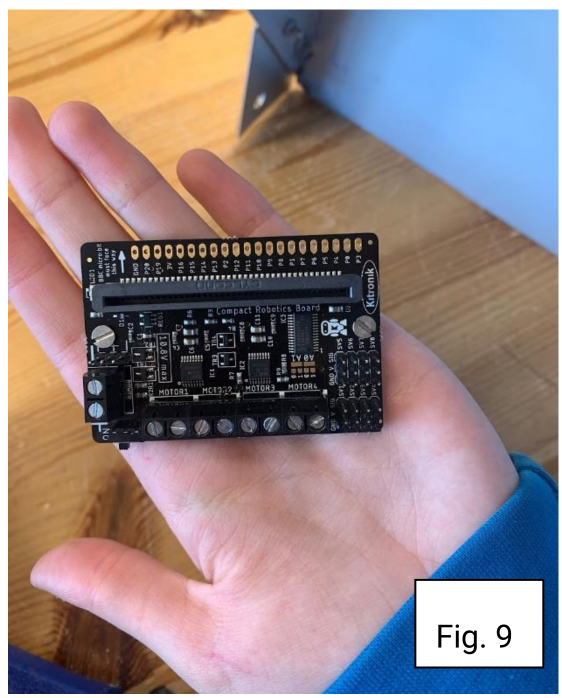

Fig. 9

the python form. We already had access micro:bits in our school so we didn't need to worry about ordering any separately.

Overall, the design phase of our project was a significant and extremely important part in our development process. This section and phase probably took the longest and most tedious amount of work, between meeting with external people and researching different design ideas. This phase also really important as we had to make sure everything, we planned out had correct dimensions and that we could start building the physical model. We also made sure to refer back to SDG goals in this phase as we wanted to use as many materials that we could use in our school as possible. We made sure to keep sustainability in our thoughts when choosing materials and using old pieces of aluminium that have been untouched. Finally at the end of this designing phase, we made the transition into fully developing out robot model.

Section 3:

Development Phase (Robot & Code)

The development phase in our project required a lot of strategical thinking and was definitely a challenging process. The previous planning and designing phases really helped during this section as we had an overall image in our minds as to what we wanted the end product to look like. We ended up having to make some slight changes we hadn’t planned originally in this section, but we reminded ourselves that it is all a part of evaluation and testing as we progress. We made sure to thoroughly test different individual parts as we developed, as one move could make it or break it. We also remembered to keep our end goal in mind, to create a robot that collects litter from the ground.

The first part of the robot we focused on creating was the base, or the main compartment. This would be the structure that holds the wheels, brush, motors, wires and Micro:Bit parts. Out of the two material options we had available: Acrylic and Aluminium, we chose aluminium as the material for this part. Aluminium is a silvery-white metal, and the 13th element in the periodic table. One thing about aluminium is that it's the most widespread metal on Earth, making up more than 8% of the Earth's core mass. It's also the third most common chemical element on our planet after oxygen and silicon. From previous engineering projects, we found that aluminium would be a great choice to use for multiple reasons. It is a sturdier material compared to acrylic, as acrylic is fonder of snapping easily. Aluminium is a lot more malleable and ductile rather than acrylic, as it’s able to bend and twist into different shapes and it rolled out into large sheets. Acrylic tends to be more brittle compared to other metals and could break or crack when put under excessive stress.

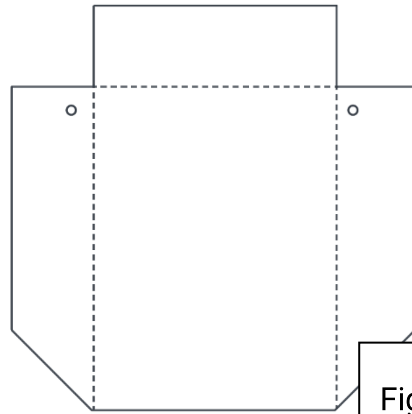

Fig. 10

We have access to large sheets of acrylic in our engineering room, and we were allowed permission to use one of them. We marked out and cut the shape of the base from the sheet (Fig. 10). The next step after cutting it was filing. Filing the piece ensures the edges and corners to be smooth and even. We made sure that the sides were smooth after because the freshly cut aluminium can scrape or cut you before it is filed. Once this part was filed, we bent each side. We bent the sides at a 90˚ angle so each side would meet to form a box-like shape. The corners ended up not bending the whole way, so we created brackets later on to close them off tighter.

Fig. 11

The next part we focused on was installing the wheels. We found these wheels in our engineering room, and we were allowed to use some for our project (Fig. 11). As seen above, the wheels attach into the two holes at the side. We drilled these holes 10mm in diameter to fit the wheel. The wheels attach directly onto the motors, so we drilled two more 3mm holes to attach the motors. We also got the motors from our engineering room, and we were allowed to use them. These sit inside the base and connect to the wheels on the outside. We made sure each of the holes were even on each side of the base so they would be even when placed on a flat surface. We only used two wheels at the back because we wanted the rubbish to sweep into the main part on a slight ramp. Having the two wheels at the back created a tiny ramp for the rubbish to sweep up into. Once all of the holes were drilled, we attached the motors and wheels together into the sides of the base. We used a few nuts and bolts to secure the motors to the sides of the base.

The images below (Fig. 12) show what our robot was looking like at this stage of the development.

Fig. 12

So far, everything was going well in the development process. We has our wheels and motors attached, so the robot could actually move. We had our first prototype created and we were ready to move forward.

Fig. 13

Our next step was to create an attachment for the brush. We ordered a set of brushes from amazon, so we had a variety to choose from. The brushes ended up being a few different lengths, so some of them wouldn't work for our robot. We decided to focus on using one main brush to attach (Fig. 13). The length of this brush was actually slightly too long for the width of our base, so we decided to cut the end of one of the sides and trim the hair down a bit. This created another bit that sticks out from the other side.


Fig. 14

This image (Fig. 14) shows us cutting one of the ends off the brush so it would be slightly shorter. We used a hack saw to cut this piece off. We then trimmed the fluff down on that end so it would be able to fit into the compartment that holds the brush. Next, we had to think about making an attachment that hold the brush onto either side of the base. The front side of the base has slanted sides so it wouldn't work to attach the brush directly onto there. We designed two pieces that attach onto either side of the base. These pieces each have a hole big enough so both sides of the brush will slot into the holes. We decided to use aluminium for this piece as well because we thought it would blend in nicely with the base.

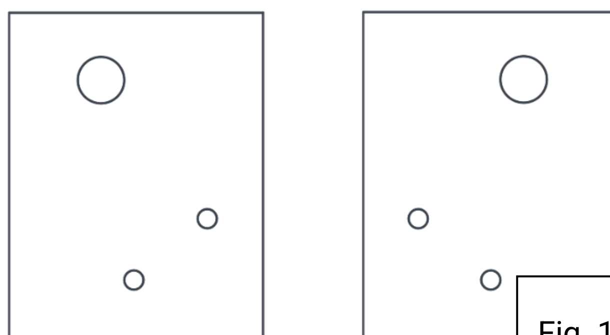
Fig. 15

The image shown (Fig. 15) is a diagram of what the two attachment pieces look like. We got a spare piece of aluminium and cut the two pieces from it. We then files the edges so they have a smooth finish. The two smaller holes connect to the base which holds them in place. The two larger holes are for each end of the brush to fit into. We drilled the two larger holes 8mm in diameter and the two smaller holes were drilled 4mm in diameter. Once the holes were drilled, we filed them and attached the pieces to the base. We used 4mm nuts and bolts to attach the two parts together. Both ends of the brush fitted into the holes nicely.

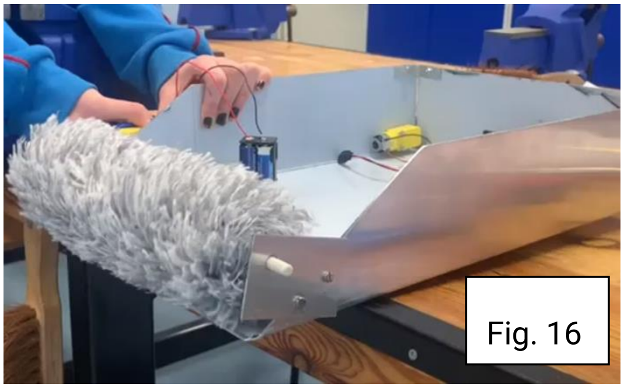
Fig. 16

The image shown (Fig. 16) shows the brush attachment on the base. You can see that there are two bolts holding the piece to the base. The brush is also attached into the larger hole. We put the attachment at a slight angle so the brush would turn smoother. After this attachment was made, we decided to go back to the base. As said before we needed to make some brackets to hold the back two corners together. We created these brackets using two small rectangular pieces of aluminium. We drilled two holes in each bracket, and bent each piece using a folding bars in the center, at a 90˚ angle. The brackets would drill into each side of the base and the brackets would help close the sides off. As shown here (Fig. 17), In the corner there is one of the brackets holding the two sides together. This helped close the two sides off so there were no huge gaps. We kept the brackets loose when we first put them on incase we needed to take them off.

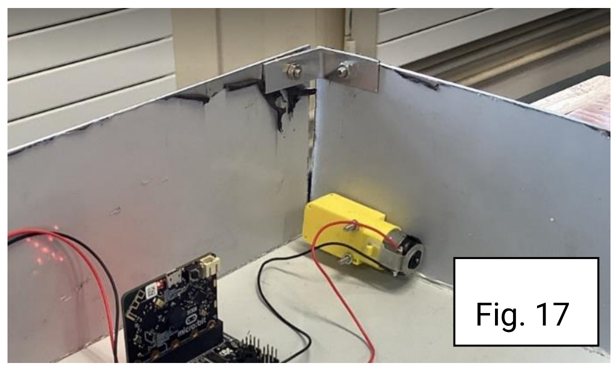
Fig. 17

After installing our brackets, we drilled two holes at the bottom of the base to hold our Kitronik All-in-One robotics board. There are two holes already on the board, so we just needed to drill holes at an equal distance into the base. Although aluminium is non-magnetic, we still put two nuts in between the base and the board just so they were separated from each other.

At this point in our development, we were quite satisfied. We hadn’t run into any major problems yet, which was great news. We had the wheels, brush, brackets, and robotics board installed and we were ready to move forward with the next steps. After this point, everything became more challenging as we had to link up the motors with the micro:bit, we had to find a way for the brush to spin, and we had to create some code for the micro:bit.

Here is an image (Fig. 18) of how our robot was looking at this stage in the development. As you can see, we have the brush and the attachment pieces on the front. We have the brackets installed at the back. Both wheels are on the back, which connect to the motors. The motors on each wheel have been wired up to the Kitronik robotics board. There is a battery holder also installed and connected to the board. After reviewing the work that we had completed, we were happy and ready to move on to the next steps.

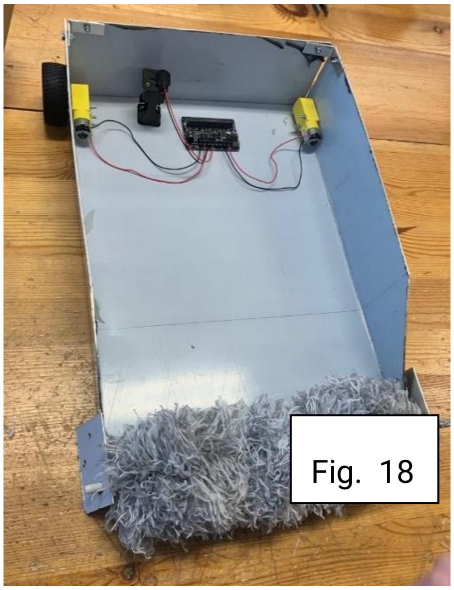

Fig. 18

We decided to do a small trial run with the Micro:Bit to see if we could get it working with the motors. We used a regular Micro:Bit V2 for the robot. We have never used micro:bits with the kitronik board before so we made sure to research beforehand. We watched a YouTube video on how to do make the wheels move on a basic scale (McCarthy, 2020). We found that the video gave us a lot of basic knowledge on how to use the Micro:Bit with the kitronik board. To code the Micro:Bit to control motors connected to the board, you go to the extensions page on the Micro:Bit MakeCode website. There are multiple extensions available, but we used the robotics extension for the All-in-One robotics board. Using the MakeCode block editor is very simple and it's easy to understand what each block is doing.

For our first variation of code, we programmed it to just move forward. We set it to if button A is pressed, both wheels will move forward, and if button B is pressed, both wheels will stop moving. We made our first version of the code very simple so we could then amend it to do more complicated actions later on.

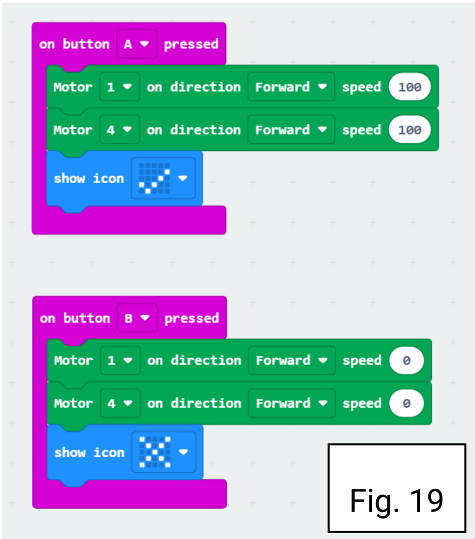

Fig. 19

Shown here (Fig. 19) is the first variation of code we created. As you can see, if button A is pressed then both motors will move forward at speed 100 (the max speed we can set it to), and if button B is pressed then both motors will move at speed 0 (they will both slow down and stop). There is also a ‘turn off motor’ button which we could’ve used, but in the video, we watched, the person said that that block can sometimes not work and it's better to just set the motors to speed 0. We included the tick and the X symbols at the end of each action, so it will indicate that the code has ran through the above actions. We also included these symbols in case we were having trouble with the code, then we would know if the error was before or after the symbol is shown.

This code worked surprisingly well considering it was our first attempt at using the Micro:Bit with the kitronik board. The Micro:Bit is placed into the designated slot, and once the switch is turned on then the Micro:Bit code will begin. The wheels moved forward when button A was pressed, and stopped when button B was pressed. With this in mind, we were able to continue working with the practical parts.

Our next step was to make the brush spin at the front. This step ended up taking longer than expected as we ran into multiple problems, and we had to make some tough decisions regarding our design. Our development has gone really well up to this point, so running into problems really disappointed us. We made sure to remember that running into problems and making mistakes is all a part of the development process. People make small mistakes all the time, and these mistakes really helped us think outside of the box. Some problems we ran into were definitely easier than others to resolve. Additionally, some of them resulted in larger problems while others made the design better in the end. This applies to the coding side of our project as well. Running into bugs is very common in coding and sometimes it can take ages to find a solution. Luckily enough, the block editor was very simple to use and understand so we didn’t have to fix too many bugs. We did have to make sure that the motors set to speed 100 on the Micro:Bit linked up to whichever slots each motor was installed into. We made this mistake once, but it only took us a short time to realise what the mistake was.

As said previously, our next step was to make the brush at the front spin. Since we chose round duster bushes, there is already a rod-type thing going through the brush already, which saved us a lot of time as we didn’t have to think about using another rod to hold the brush. This step took the longest in our development process and we ran into multiple problems and ended up having to change multiple pieces.

We began by attaching another motor onto the left side of the base. We put the motor on the outside so the motor would spin the brush from the stick bit at the end. To make the brush spin, we had to think of a way to make it spin with the motor. We decided to use two pully wheels. One wheel would connect to the motor, and the other wheel would connect to one end of the brush. If we attached a pully belt to both wheels, they would both spin with each other and then the brush would spin. One problem and had to be cautious of is that in order for the brush to spin, the pully belt needs to be really tight. In order for the pully belt to be tight, the motor needs to be at the correct distance away from the brush, so the wheel on the motor will be strong enough to pull the other wheel. Before we drilled the holes for the motor, we made sure to put the motor at the right position. We got it at the right position after a few tries. We fell into the problem when we drilled the holes. We aren’t sure exactly where we went wrong, but we think that before we marked the holes out, we lost the correct position for the motor. This small mistake made a huge impact on the next few steps in the development.

Fig. 20

Shown here (Fig. 20) is how the motor attaches to the brush using the pully wheels and belt. You can view the video of the brush spinning before the motor was attached on our website, in which there is a QR code for our final website in the testing section of this report. As you can see from the images showing the top of this piece. The smaller pully wheel doesn't line up perfectly with the other wheel. Because of the shape of this end of the brush, the smaller pully wheel kept moving out of the correct place when it was moving. This was affecting how the brush was spinning and was causing the brush to get stuck every so often.

With all of these problems in mind, and a short few weeks left to complete this project, we were stuck. We made the decision to have a chat with our engineering teacher and see what his suggestions would be. We weren't exactly looking for his help, but we were looking at what his advice would be for our problem. This was also the first huge problem he had to bring up to him as everything before this was working well. He suggested that we design a different piece that connects to the base and wraps around to connect to the end of the brush. He told us that creating a different piece could help the small pully wheel from moving out of place and hopefully make the brush turn better.

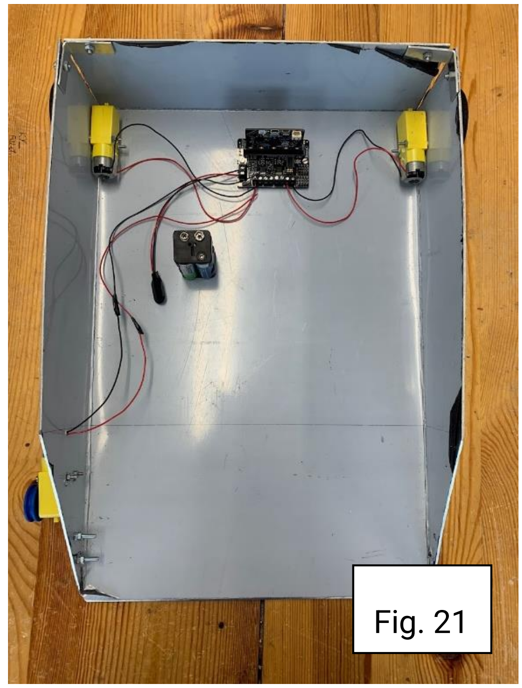

Fig. 21

This is what our robot was looking like at this stage in the development process (PS the brush and attachment were taken off when we took this photo). As shown (Fig. 21), The Micro:Bit is in the designated slot on the kitronik board, all of the motors are in each motor port, and the motor at the front is connected to the base and has the large pully wheel attached to it. As you can see in the image, we drilled another hole to feed the two wires into, as they have to connect to the kitronik board. The original wires on the motor were too short so we extended the wires to make sure it was long enough to fit into the board.

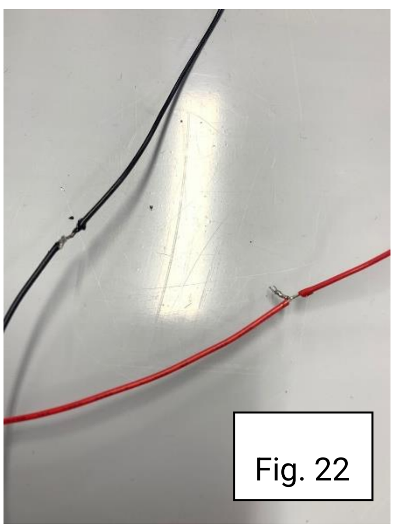

Fig. 22

The process of connecting wires together is called soldering. Solder is a fusible metal allow with a melting point (or range) of 90 to 450˚C, used in a process called soldering, in which it is melted to join metallic surfaces (Schwartz, 2014). We made sure to be careful during this process because it is dangerous considering the soldering iron gets up to really high temperatures. Once the soldering was completed (Fig. 22), we wrapped the parts with tape so they wouldn’t get ruined.

Next, we focused on creating the attachment suggested by our engineering teacher. We designed this piece so that it connects to the base like the previous brush attachment, but it also wraps around and has another hole for the end of the brush to slot into. We used another piece of spare aluminium that we found at the back of our engineering room. We marked out the dimensions and holes. After, we cut the piece, files the edges, and drilled the holes. We then bent the piece in the correct areas at 90˚ angles so it would form a box-like shape. We used folding bars to bend this piece. Some of the holes ended up not lining up correctly, so we used small needle files to file the insides of the holes.

Below are a few images of what this piece looks like (Fig. 23, 24, 25).

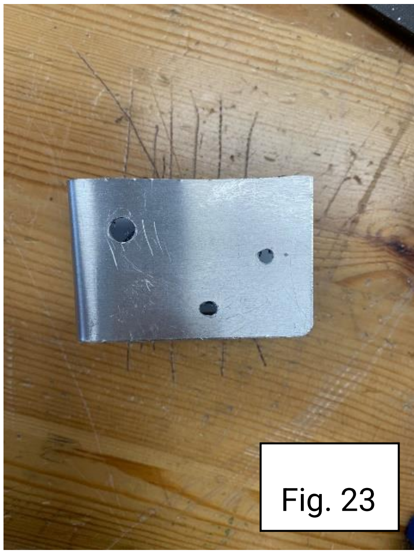
Fig. 23

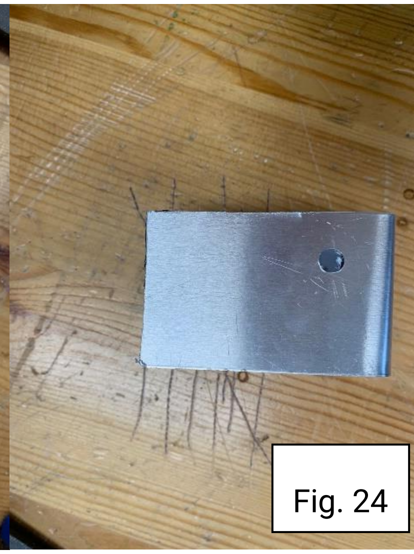
Fig. 24

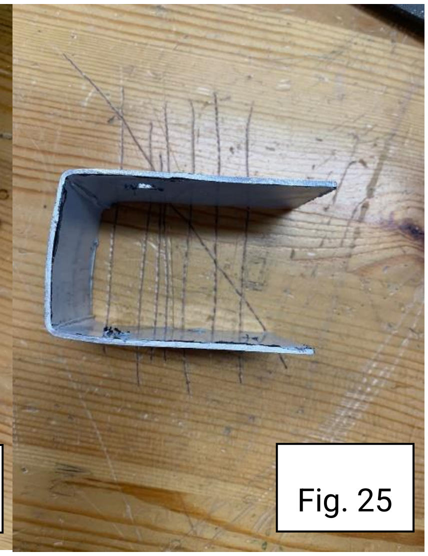
Fig. 25

The first image (Fig. 23) shows the right-hand side of the piece (the part that connects into the base), the second image (Fig. 24) shows the left-hand side of the piece (the part that the end of the brush slots into) and the third image (Fig. 25) shows the top view of the piece. You can see in the third image that the two corners are bent at 90˚ angles to form a box-like shape. The brush passed through the large hole in the first image, and the end of the brush is slotted into the hole in the second image. The pully wheel will be between these walls, meaning it should stay in place when it is spinning.

When we attached this piece onto the side of the base, we noticed that the pully belt was no longer tight from the position of the wheel. Since it became loose, this meant that the wheel wouldn't spin, and if the wheel doesn't spin then the brush wont spin. This became another problem on top of the other problems we were having, and we needed to think of a solution of this as soon as we could.

There were a few reasons why this problem was occurring, Firstly, the attachment piece was bent in a way that it wasn't even, so whenever the motor was turned on the piece kept moving inwards. Another cause of this problem is that the two holes that the brush slotted into was on a diagonal, so it was causing the pully wheel to come loose. Coming to the final few days to complete our project, we had to think about a solution for this quickly. We had the idea to attach a rod from one side of the attachment to the other. This would stabilize the two sides and prevent them from turning inwards. Our backup plan if this didn't work, was to attach another motor on the other side so there would be two motors spinning the wheel (We **didn't** have to use this backup plan in the end).

Back to the building, we began by taking everything apart from the attachment so we could focus on getting that fixed. We marked out another hole opposite from one of the other holes and drilled it. We had to make sure these two holes were perpendicular to each other because if they weren't, the brush wouldn't be able to spin. Once these holes were drilled, we made sure they were perpendicular to each other and put the rod through the piece. We tried to get the whole thing working again, but still no joy. We were definitely seeing some improvement, but it kept getting stuck somewhere when the motor was turned on. We decided to trim the hair a little bit more around where it was being fed through the hole. This way, the brush would be able to rotate smoother without the hair stopping its rotation. Finally, after trimming the hair and putting everything back together, it finally started working again. Once everything was put in the right position and all of the pieces were at the correct angles, it started spinning smoothly. We felt very relieved after this was working again. We linked the brush motor into the kitronik board, updated our code, and did a quick test run of the robot. Luckily enough, both back wheels were moving and now our brush was spinning. We felt extremely happy achieving this, especially considering we were close to the finishing date. We did notice some minor problems while doing this test run, and we took that into consideration.

Now since we had the front wheel working, we were reaching the final few steps to complete our project. One of our next steps was to attach the switches to the front of the robot. This switched play a really important role when our robot is functioning. We had to also think about this element when were in our planning phase. If the robot hits into a wall, or anything blocking it from moving forward, then it has no way of telling itself to move away from the way. We got the idea to use two switches on both front corners of the robot to try fix this problem. If the robot hits into a wall and one of the switches click, it will basically tell the robot to reverse and turn in a different direction. This way, we won't have too many issues with the robot accidentally running into walls. The switches connect to wires, which connect to the pins located at the back of the kitronik board. We will add a function to the code that if one of the switches are clicked, the robot with reverse, rotate and move in a different direction.

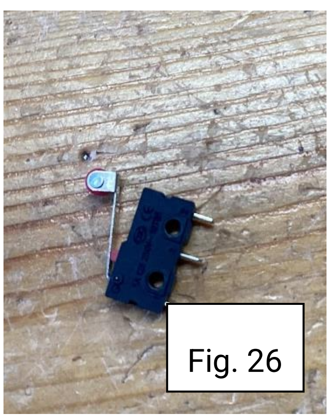

Fig. 26

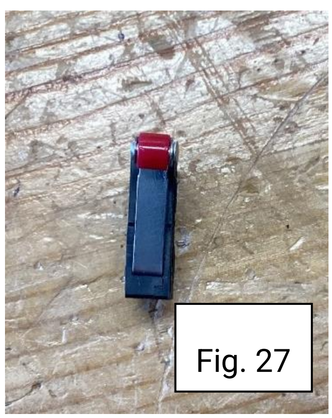

Fig. 27

Here, (Fig. 26, 27) are some images of the switches. These are called Limit switches, an analogy could be referring to them being like a cat's whiskers, if it senses something or hits something it knows, it can't/ won't fit or it won't pass through the object. We found these in our engineering room and were allowed permission to make use of them. The pins at the back will connect to wires, which with further connect to the kitronik board. We also had to design an attachment for these pieces because they couldn't be placed directly on the robot without an attachment.

We decided to use a small, rectangular piece of aluminium to create the attachment. We came up with the idea of twisting the aluminium so that one end would attach vertically to the robot, and the other end would be horizontal with the switch. Putting the switch horizontal means that if it hits into a wall, it will more likely click if placed horzontally rather than vertically.

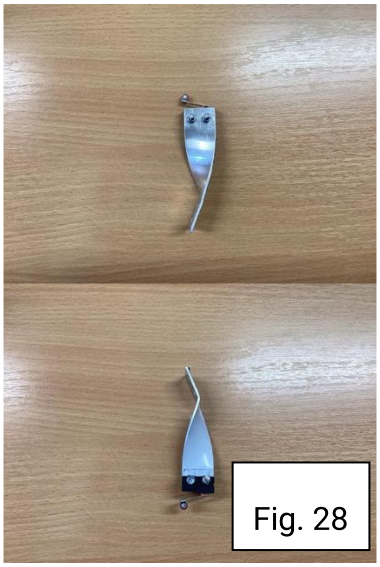
Fig. 28

Here, are two images of our switches. We drilled four holes in this piece: two for the switch, and two for attaching it to the main piece. We twisted this piece so one end would be vertical and the other would be horizontal. As seen in the bottom image, the end is slightly bent so that when we attach the piece to the robot, it will stick outwards at an angle. We also used aluminium for these pieces to tie in with the rest of the parts. The little pins at the back attach to wires, which then attach into the pins in the back of the robotics board. Once these pieces we finished, we attached them onto the two front sides of the robot to see what they would look like.

Here (Fig. 29), is a few images of the switches when we attached them to the base. We attached them on the two front corners of the robot. As you can see, the two bolts go into the brush attachment at the front. Our next step after attaching them was to wire them up to the Kitronik board.


Fig. 29

We were approaching the final few days to complete our project. We had to keep working consistently and make sure we were using all the time we could to complete this project. We ended up having to take extra class time to complete this project, which we were allowed to do so. We additionally had to balance time between finishing this and also completing other aspects of our project. We were overall happy with where we were at in the development, as if things when downhill our project may have not been completed. The final few steps included the following: wiring the switches to the board, finalising the code, wrapping with vinyl and attaching our CCS acrylic letters to the side (decoration). Once the wiring of the switches and finishing the code was complete, we were able to focus on the 'fun' parts which included decorations and tidying everything up, so it looks a bit nicer.

Now that the two front switches were attached to the front, we were ready to finish everything up. The next thing we had to do was wire these up to the robotics board. We soldered the red wires into the NO (Normally Open) pins and black wires into the ground pins. We then soldered them into P0 and P1 in the back of the robotics board. However, before we soldered them, we made sure they were working smoothly.

We updated our code so that if P0 or P1 is pressed, the robot will reverse, turn, and move in a different direction. We had a few bugs in our code and had to try a few different methods to try get this right. We used conditional statements so that if one of those are pressed, it will execute a certain action. We tested the code multiple times to make sure that it was as perfect as we could get it.

Our final step, was to vinyl and attach our CCS letters onto the robot. We left this step until last incase something didn't work and we wouldn't have a complete project. The vinyl was definitely hard to attach, as it had to be the correct dimentions and we had to cut it using a scapel. We used a heat gun to get the airbubbles out of the vinyl once we stuck it onto the pieces. This was a very tedious job but it worked out in the end. Lastly, we cut out white acrylic letters (CCS) to put on the side. This shows a nice representation of our school on the robot. We drilled tiny holes to screw these letters onto the side using nuts and bolts.

Section 4:

Testing Phase

The testing phase mainly took place at the end of our development, but we made sure to test everything thoroughly throughout the development process. We tested the robot by placing it on a flat surface like a table or the floor, and we let it roll on its own. We had to test various things, like the brush spinning, the motors working, and the Micro:Bit code. Testing definitely played a very important part in our project. Computer Science and engineering involve a lot of testing, especially when in alpha. Our project didn't involve the need for much beta testing as people wouldn't necessarily be interreacting with it, and they would more just let it roll around. Although we could've possibly beta tested it, there wasn't enough time to get a group of beta testers.

The last testing we completed, was just before we put the vinyl on. We were having troubles with code, so we had to research and try fix the problems we were having. Each time we updated the code on the Micro:Bit, we made sure to test it out on the robot. No matter now big or small a change in the code was, it impacted the way the robot works. We made sure to save multiple versions of the code in case we made more mistakes and needed to go backwards to find a working version.

Like said before, we were running very short on time to get this completed. We decided the best way to share our results with the public would be to create a website to showcase our results. Our website with multiple pictures, videos, and results can be viewed using the QR code here. This was **NOT** a key factor of our project, and was additionally added in.

Results

After testing the robot a few times, we have some overall results we can communicate.

First of all, we are glad to say that our robot designed to pick up litter is in a working state. Going back to our hypothesis, we intended to create a robot designed to clean litter, and we believe we have achieved the brief of what we set ourselves to.

Our robot works extremely well at picking up smaller litter items, for example, tissue, small pieces of paper, sweet wrappers or small pieces of waste. We intended our robot to pick up litter on a small scale, as we wouldn’t have had time to create anything too much more advanced. Our robot is able to navigate and move across the floor easily. It is also great at executing the appropriate gestures when either of the switches are pressed, when it hits into a wall.

Our robot moves very smoothly and well, although it can sometimes be slow or get stuck in a crack in the floor. We found that the floor in our school's corridor was a very smooth surface for our robot to move on. Whereas when we tested it on a wooden table, it didn’t move as smoothly.

Like said before, we didn’t have enough time to include a load of images of the final product. We have our website with live updated images and videos of our robot, which can be viewed using the QR code in the testing section.

Overall, we believe that our robot worked extremely well considering we didn’t know much about robotics going into this project initially. We believe we have achieved a minimum of what we originally set ourselves to and hope to possibly create something even more advanced in the future.

Conclusions

We think that robots should be used more for picking up litter for many reasons. It would require little to no time wasted picking litter up when a robot can do it. Robot vacuum cleaners can be purchased very easily because a lot of shops sell them. Some of them even have the option to clean floors while also vacuuming. Robotics plays a major role in the design of the robot, which plays a major role in our daily life. Even though robotics is used in daily life, we think that it could be used more in the context of littering.

Using robots to pick up litter offers several compelling advantages, including:

1. **Efficiency:** Robots can work tirelessly without getting tired, covering large areas efficiently and consistently. Robots can operate around the clock, providing continuous litter removal services. This enhances the speed and effectiveness of litter collection.
2. **Precision:** Robots can be programmed with accurate movements, allowing them to navigate through different surfaces and target specific areas for litter removal. This precision minimises the chance of missing debris. They can handle hazardous materials and navigate challenging environments, reducing the risk to human workers.
3. **Cost-Effectiveness:** While the initial investment in robotics may be significant, the long-term cost-effectiveness can be realised through reduced labour costs and increased efficiency in litter collection and waste management.
4. **Technological Advancements:** Robotics technology continues to advance, allowing for the development of smarter and more capable robots. This can

lead to improvements in the effectiveness and adaptability of litter-picking robots.

5. **Environmental Impact:** By automating the litter collection process, there is potential to reduce the environmental impact of waste on ecosystems and wildlife, contributing to a healthier and more sustainable environment.

While there are many benefits for using robots in the context of litter picking, there are disadvantages that come with the technology.

Some of the **disadvantages** could include:

1. **High Initial Costs:** Implementing robotic systems for litter collection involves substantial upfront expenses, including the development, purchase, and maintenance of the technology. This financial investment may be challenging for some communities or organizations.
2. **Job Displacement Concerns:** The widespread adoption of robotic litter collection could lead to concerns about job displacement for manual labourers in the waste management sector. This may have social and economic implications for communities dependent on such employment.
3. **Technological Limitations:** Robotics may face challenges in adapting to diverse environments and handling various types of litter. Current technology limitations may result in inefficiencies, especially in complex or unpredictable settings.
4. **Maintenance Challenges:** Robots require regular maintenance, and breakdowns may occur. Ensuring a reliable maintenance schedule is crucial to prevent interruptions in litter collection services, and addressing technical issues promptly is essential.
5. **Limited Decision-Making Abilities:** Robots may lack the ability to make nuanced decisions, especially in situations requiring human judgment.

Identifying and handling specific litter items correctly, such as delicate or valuable objects, may be challenging for robotic systems.

Introducing robots for litter pickup in schools not only efficiently maintains cleanliness, but also serves as an educational tool. Equipped with sensors and autonomous capabilities, these robots navigate school premises, providing a hands-on experience for students in programming and responsible waste management. This innovative solution not only contributes to a cleaner and safer environment but also saves time for school staff, allowing a focus on educational priorities. The use of robots promotes a technologically progressive and environmentally conscious atmosphere in schools.

Our Improvements

There were many challenges to do with our project, mainly given time. There was a limited time to have the practical part done and had we take time from classes to get work done. We initially only took one hour a week to do project work, but we ended up having to increase that time significantly. We were only given around 4 weeks according to the TeenTurn plan for the practical work, in which we definitely took more than 4 weeks to do the practicals.

Our project is designed for indoor use, so the wheels are not very functional with outdoor materials. The wheels would most likely not work on rough terrain outside. The duster brush would get damaged and dirty if used outdoors. Plus, the aluminium would corrode.

The bottom of the robot is also quite low to the ground, so if the robot were to drive over a stone or on an uneven surface (outside), it would have some problems and probably be damaged. Again, if we designed this for outside use we would have to modify the design of this part.

If we were to restart this project, we would definitely manage the time more efficiently, have a more structured plan, and be more accurate with measurements We would also take time to draw proper diagrams of each piece before creating the physical part. We also think if we were to restart, we could take a few different design ideas and merge them into one, instead of going based on one or two main designs.

If we were to continue this project, we would definitely tidy up the pieces and replace any of them that had drilling mistakes or other scratch marks. We also came up with the potential idea make a reusable charging bank for the batteries and we could power the charger by using mini solar panels and wind turbines, so that we don't waste unnecessary production. We also thought about how AI can be implemented into our robot. AI could enhance our robot by enabling advanced computer vision for recognizing and prioritizing litter types, while machine learning refines its collection strategies. AI also aids navigation, making the robot smarter and more adaptive to efficiently address diverse litter challenges. We would obviously need more experience and a lot more time if we wanted to add these additional features in.

We also thought about how we could use and recycle materials in the future, like recycling parts from old cars. E.g. using the parking sensors on cars and using them as a way to guide the robot around and detect litter and cause the arm to spring into action.

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Appendices - Our Micro:Bit Code

Here, you will find all of our Micro:Bit code for our robot. We decided that this section is the best place to include the code as it would be easier to show the final code here. The GitHub repository with the Micro:Bit code also can be viewed by using the QR code here:

References

Agarwal, P. (2023, February 6). *Robotics: Indroduction*. Retrieved from GeeksForGeeks: https://www.geeksforgeeks.org/robotics-introduction/?ref=gcse

ApS, S. (2023). *Agricultural rock picker for ATV / UTV.* Retrieved from Youtube: https://youtu.be/kJH_UpnQvqY?si=JM8F8Blxza6HO_k.

Corona, E. a. (2013). "A review of lean-kanban approaches in the software development.". *WSEAS transactions on information science and applications 10,*, (pp. 1-13).

DECC. (2021). *€5 million additional funding for litter prevention and cleaning as Ireland prepares for an outdoor summer*. Retrieved from Gov.ie: https://www.gov.ie/en/press-release/c4f6e-5m-additional-funding-for-litter-prevention-and-cleaning-as-ireland-prepares-for-an-outdoor-summer/

Fowler, M. a. (2001). "The agile manifesto.". *Software development 9, 8*, 28-35.

Green-Schools. (2021). *Litter & Waste - Green-Schools*. Retrieved from greenschoolsireland.org: https://greenschoolsireland.org/litter-waste/

Maeda R, B. D. (2021). Influencing moral behavior through mere observation of robot work: Video-based survey on littering behavior. In Proceedings of the 2021 ACM/IEEE international conference on human-robot interaction. 89-91.

McCarthy, P. (2020, December 12). Retrieved from Youtube: https://youtu.be/YwrGd0FTWp4?si=ESHlvilqSCMaDY9w

Soori, M. A. (2023). Artificial intelligence, machine learning and deep learning in advanced robotics, A review. Cognitive Robotics.

What is aluminium. (2023). Retrieved from What is aluminium: https://aluminiumleader.com/about_aluminium/what_is_aluminum/

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